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(DURIP00) ELECTRON BACKSCATTER DIFFRACTION (EBSD) SYSTEM FOR CRYSTALLOGRAPHIC IMAGING IN A SEM

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13. ABSTRACT *(Maximum 200 words)*

The Electron Backscatter Diffraction (EBSD) System was purchased and installed. Training is currently ongoing and the technique is being used to probe a variety of research problems including work support by our AFOSR/DARPA ferroelectric project. Imaging using EBSD is a relatively new, powerful, and elegant characterization technique for measuring micro- to mesostructural crystallography. As part of a SEM system, EBSD involves indexing the Kikuchi patterns formed by electrons backscattered from the sample. Through computer automation, the electron beam is slowly rastered over the sample as the pattern from each spot is analyzed. The result is an image of the microstructure based on crystallographic orientation. It should be noted that this capability has only been commercialized since 1993. EBSD provides sample resolution fine enough to crystallographically index individual grains, while offering a field of view large enough and data processing fast enough to provide statistically significant measurements of texture on either a localized or global basis. This coupling of fine resolution and relatively wide field of view makes it possible to analyze textures in virtually any type of sample from semiconductors, piezoelectrics, geological rocks, etc.

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August 28, 2001

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Final Technical Report for acquired equipment obtained from the Grant No. F49620-00-1-0231

Research title:
"(DURIPOO) Electron Backscatter Diffraction (EBSD) System for Crystallographic Imaging in a SEM".

Principal Investigator:
Professor Gary L. Messing
OIM (Orientation Imaging Microscopy) equipment purchased from TSL Inc. (contact person is John Bennison, President of TSL, Inc.(801-495-2750)

OIM Advanced System comprising:
SIT camera system including image processing
Customized camera/SEM interface for Hitachi 3500N SEM
OIM/ADV software including beam control
500 MHz Pentium PC including monitor and video card

Total cost	$95,000.00
Covered by Penn State University	$25,650.00
Grant	**$ 69,350.00**

The OIM system as described in our proposal was purchased from TSL, Inc., now EDAX/TSL.

A special effort was made for the arrangement concerning the installation of the new OIM camera to the existing Hitachi S-3500N. This included several conversations with the OIM camera designer, and photos of the SEM column. A live video conference was held together with the TSL company at December 1, 2000 with participation from TSL representatives and MRL colleagues for the discussion of necessary details and measurements.

The OIM system arrived at Penn State in January 2001. The preliminary installation was followed by several days working with the TSL technical personnel finding optimal SEM conditions for the best OIM camera performance plus designing special sample holders suitable in the existing SEM, different from the standard sample holder offered by the TSL company.

The final installation to the existing Hitachi 3600N SEM was accomplished at March 13-14, 2001. The TSL personnel gave training sessions covering sample preparation, use of the camera, use of the image processor, system calibration, indexing of EBSD images, conducting an OIM run and data analysis. Four graduate students and Drs. M. Klimkiewicz and E. Breval attended the training sessions. The OIM /SEM system is under the supervision of Dr. Maria Klimkiewicz. She trains all users of the OIM and as of today 15 students have finished the training. The OIM/SEM system is available for use to all students, faculty and staff of The Pennsylvania State University.

The OIM data analysis software was also installed in the student computer laboratory as a second station for software learning and data analysis.

The research projects described in our proposal, which need the use of the OIM technique, are mostly about non-conductive materials. To obtain good EBSD patterns from non-conductive samples after polishing, they have to be coated with a carbon film 10-20 angstroms thick. We were using our existing carbon coater, but we could not obtain satisfactory carbon films and as a result EBSD images were of a too low quality for recording and data analyses. To solve this problem TSL recommended the use of a GATAN PECS system (model 682), which they use for coating, but the price of system is very high.

At our request the Penn State Nanofabrication Facility Laboratory has offered to help, and they will adapt their existing Kurt Lesker E-gun/Thermal Evaporator for metals to also be able to coat with carbon. This evaporator is able to deposit high resolution films with thicknesses down to 10 Angstroms with great reproducibility and to monitor this thickness with good accuracy. They have ordered needed parts, and while we are waiting for the parts the Penn State Nanofabrication personnel trained four of our students to use the evaporator.

We have been getting good OIM results with conducting materials, which we used for learning, practice, and for obtaining experience in the use of the OIM technique.